SEP Working Team and Scoreboard Status Report

Ian Richardson

Department of Astronomy,
University of Maryland and
NASA Goddard Space Flight Center

SEP Scoreboard (https://ccmc.gsfc.nasa.gov/challenges/sep.php):

Collaboration of CCMC (Leila Mays, Masha Kuznetsova)

BIRA (Mark Dierckxsens)

UK Met Office (Mike Marsh)

SEP Scoreboard Planning Group

Ian Richardson (UMD/GSFC),
Jesse Adries, Veronique Delouille (SIDC),
Nathan Schwadron (UNH),
Marlon Nunez (U Malaga),
Anastasios Anastasiadis, Olga Malandraki (National Observatory of Athens),
A. Posner (NASA HQ),
B. Heber, J. Labrenz (Univ. of Kiel) …

Examples of SEP Prediction Models

Continuous/ Probabilistic

Continuous Probabilistic:
SWPC
UK Met Office
MAG4 (Falconer)
FORSPEF (NOA)

Continuous Profile:
PREDICCS (UNH)

Non Near Real-Time/ Complex

CSWEPA MAS+EPREM (PSI and UNH)
EPREM (UNH)
EPREM+cone (UNH)
EPREM+ENLIL (UNH + Odstricil)

iPATH (Li)
SEPMOD (Luhmann)
SPARX (Dalla, Marsh)
SWMF FLAMPA (UMich)
Zhang Model (FIT)

Solar Event Triggered

Flare:
AFRL PPS
COMESEP SEPForecast (BIRA)
FORSPEF (NOA)
SPARX (Dalla, Marsh)

Flare and CME:
COMESEP SEPForecast
FORSPEF (NOA)
SOLPENCO (Arans)

Flare and proton flux:
UMASEP (Núñez)

CME:
Richardson SEP formula
St. Cyr (Mauna Loa CME)

Electron flux:
REleASE

Flare, Radio, H-alpha:
SWPC PPM

Flare, Radio:
Laurenza Model

Radio:
AER SEP Model (Winter)

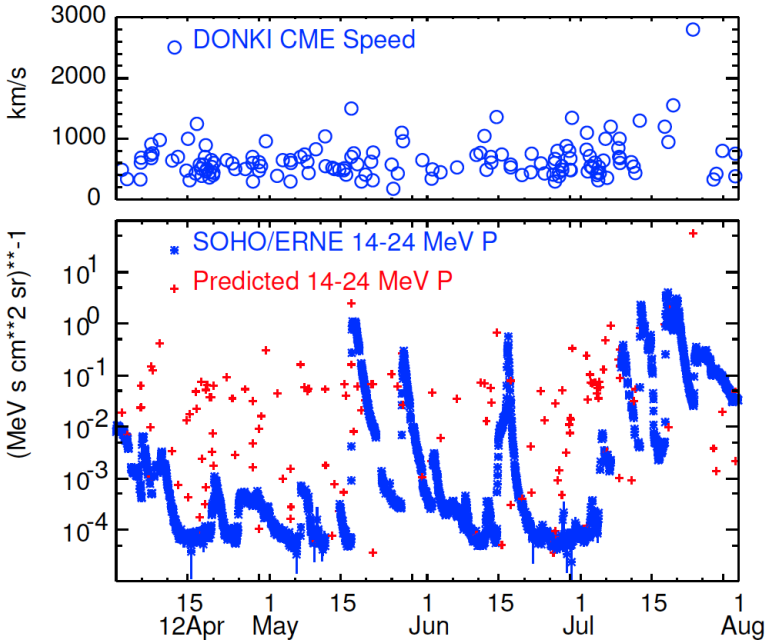
Bolded models have already confirmed participation in the SEP scoreboard

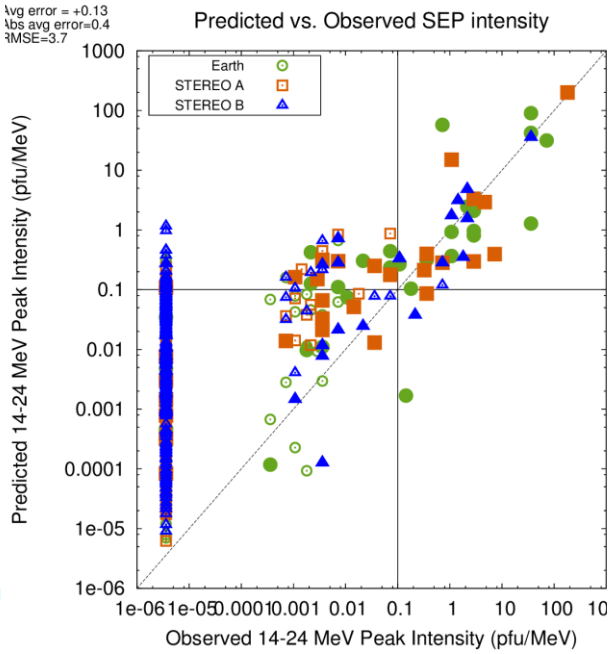
Prediction of Solar Energetic Particle Event Peak Proton Intensity Based on a Simple Algorithm Using CME Speed and Direction and Observations of Associated Solar Phenomena

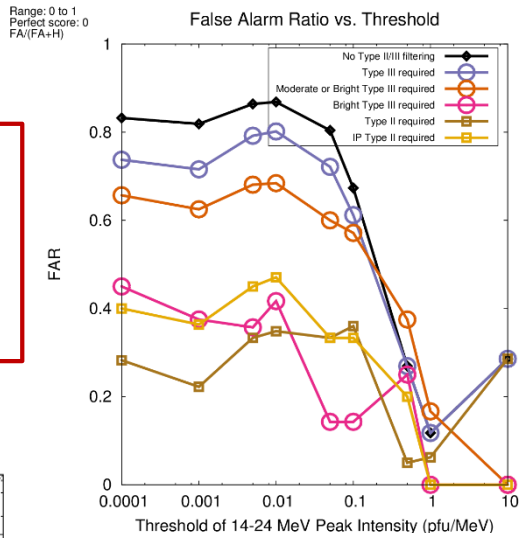
Solar Physics, in preparation

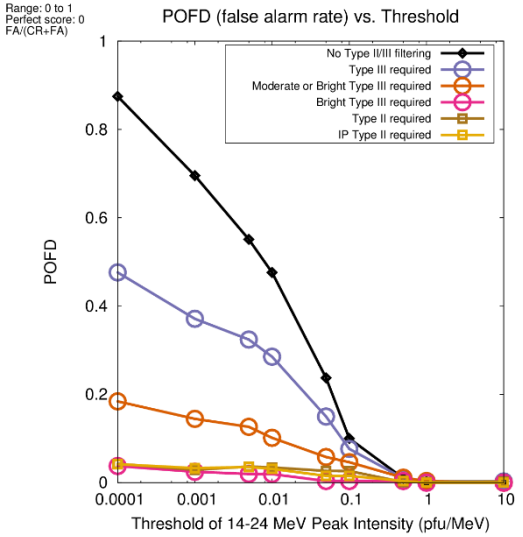
I. G. Richardson[1,2] · M. L. Mays[1] · B. J. Thompson[1]

Finding: Requiring Type II and type III radio emissions to accompany the CMEs helps to reduce the false alarm rate/ratio of predicted SEP peak flux from the Richardson et al. (2014) formula, showing potential as a simple SEP prediction tool.









$$I(\phi)\ (\mathrm{MeV\ s\ cm^2\ sr})^{-1} \approx 0.013 \exp(0.0036V - \phi^2/2\sigma^2)),\ \sigma = 43^o$$

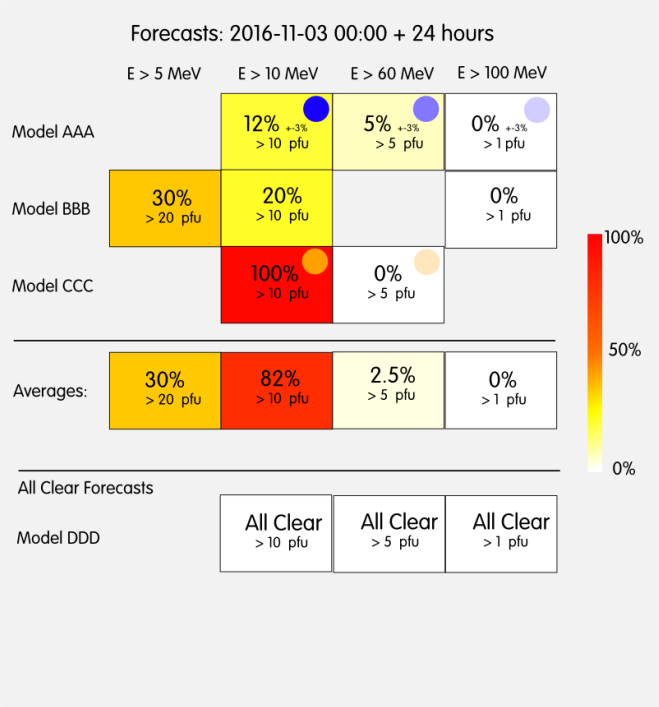
What SEP parameters should be predicted? E.g.,

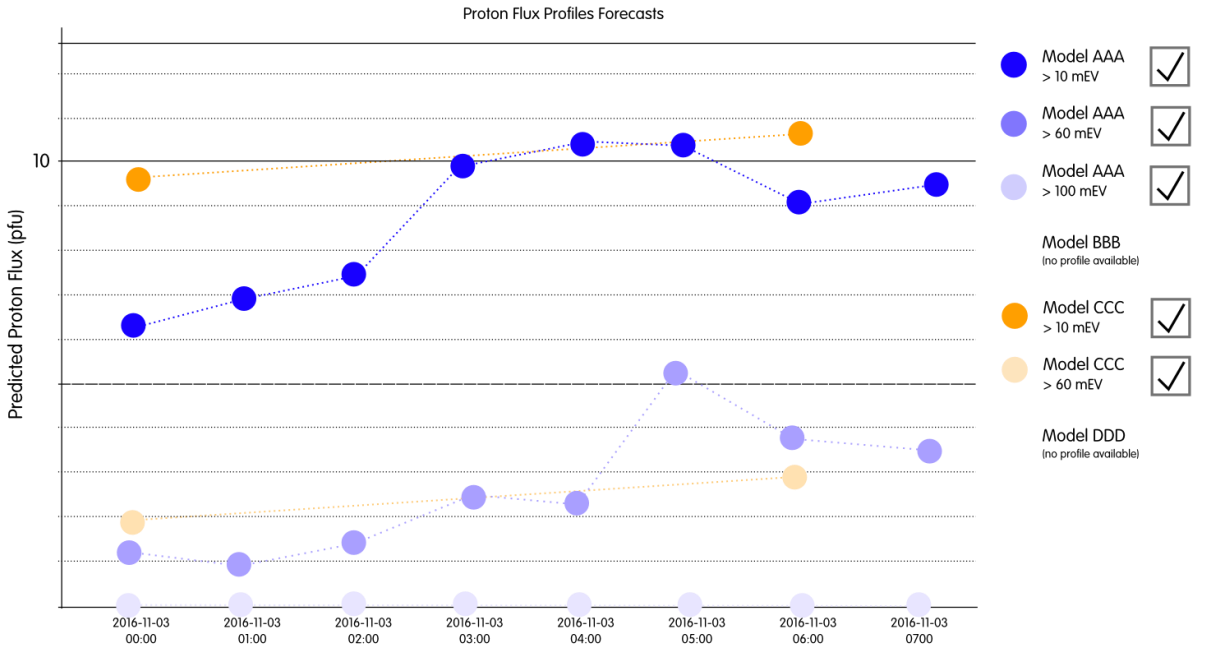
- **Peak intensity/time of peak intensity?**
- **Onset time/time to first cross intensity threshold?**
- **Duration above a particular intensity threshold?**
- **Intensity-time profile?**
- **Event-integrated fluence?**
- **Probability of an SEP event above a certain intensity occurring in the next n days (e.g., rocket launchers) or n hours (aviation)?**
- **What location? E.g., Earth/other locations?**
- **At what energies? E.g., standard NOAA GOES >10 MeV proton flux is of little interest to aviation but of value to spacecraft operators.**

SEP Scoreboard Planning

Display ideas

SEP Scoreboard





issue time: 2016-11-03 00:00 ▼ ▶ settings ▼ models ▼ Download Data

Probability heat map at a single time

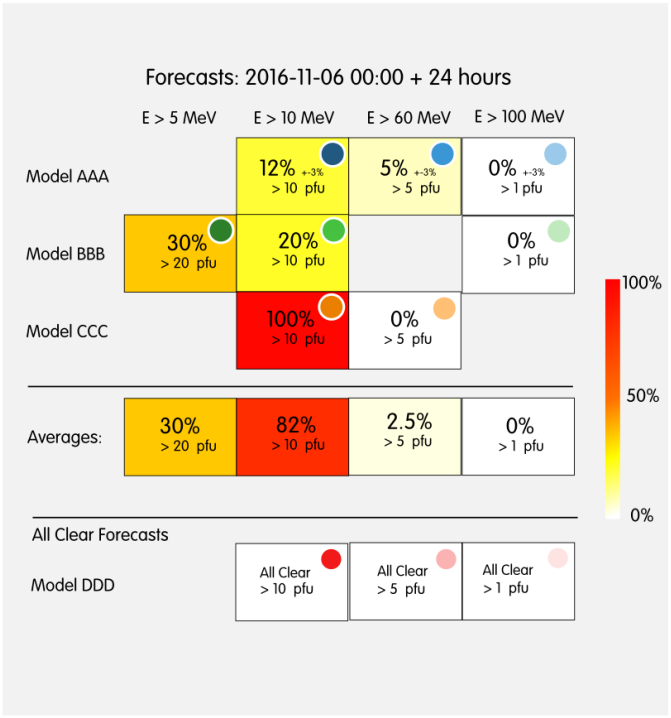
https://ccmc.gsfc.nasa.gov/challenges/sep.php

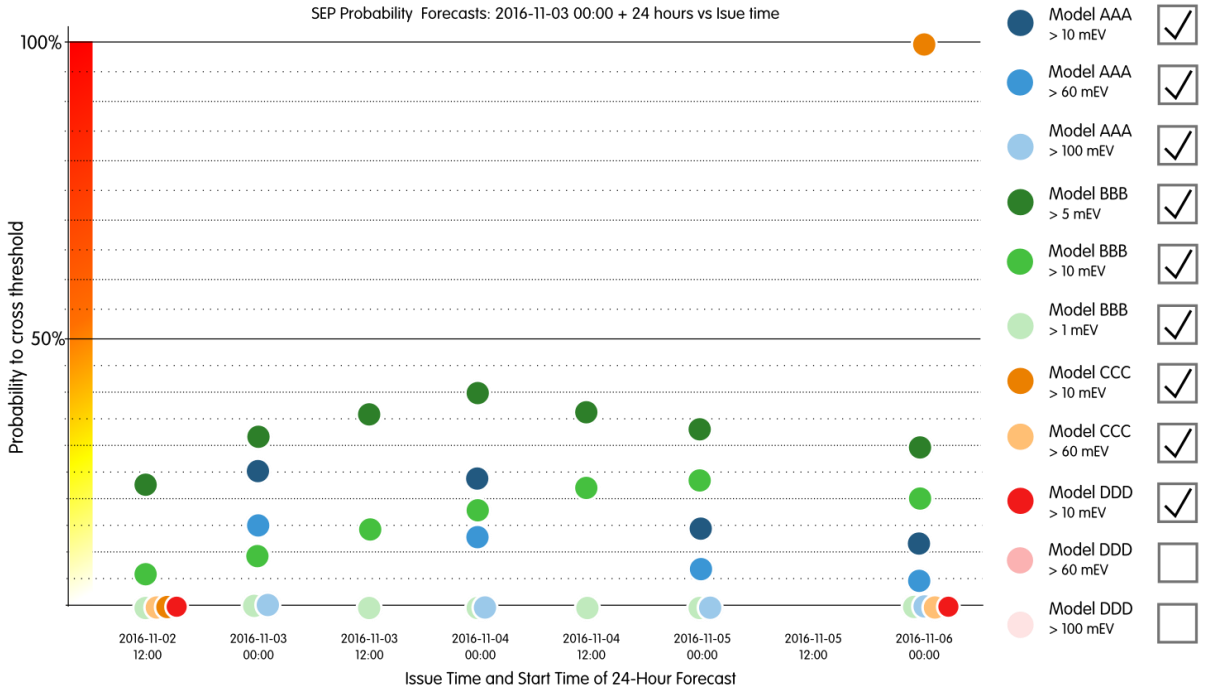
Predicted proton flux time-series

SEP Scoreboard Planning

Display ideas

SEP Scoreboard





Probability heat map at a single time

https://ccmc.gsfc.nasa.gov/challenges/sep.php

Probabilistic forecast

Relevant SHINE Workshop sessions: SEP Models in the Community

(SHINE: July 30—August 3, 2018, Cocoa Beach, FL)

Sessions:

Coupled heliospheric and solar energetic particle models

Organizers: Christina Lee (UC Berkeley), Janet Luhmann (UC Berkeley), M. Leila Mays (NASA/GSFC)

Predicting solar energetic particles: community campaign

Organizers: M. Leila Mays (NASA GSFC), Hazel Bain (NOAA SWPC), Ian Richardson (UMD/NASA GSFC)

Is Understanding Magnetic Field Connectivity Crucial for Understanding Solar Energetic Particle Events?

Organizers: Hazel Bain (NOAA SWPC), Ian Richardson (University of Maryland/GSFC)

Conclusions

Planning for the SEP scoreboard is continuing, but with the low occurrence rate of SEPs approaching solar minimum, there has been little opportunity to collect real time predictions that may be used to help develop the scoreboard.

It is probable that after the fact “predictions” of past events will provide the main input in the coming years of low solar activity.